Ground Bearing Pressure: Practical Applications for Lifts of All Sizes

Host: Mike Parnell
President/CEO,
Industrial Training International

Guest Speaker: Jim Jatho
Heavy Lift & Rigging Planner,
Buckner Heavylift Cranes

The views expressed in this presentation are that of ITI and are not necessarily the views of the ASME or any of its committees

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We Rig it Right!
iti.com

WHO WE ARE

A world leader in crane and rigging training and consulting.

We Rig It Right!

WHO WE ARE

We Serve a Variety of Industries

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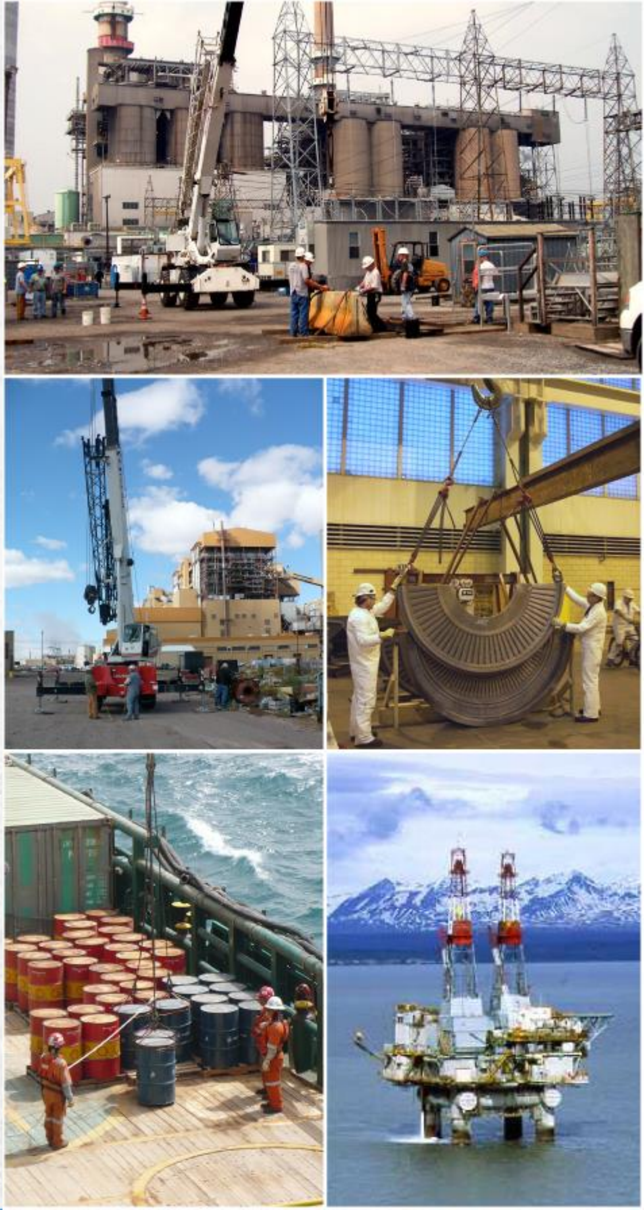
- Chemicals
- Construction
- DOD
- DOE
- Electric Utility
- Hydro
- Manufacturing
- Maritime
- Mining
- Nuclear
- Oil & Gas
- Pulp & Paper
- Railroad
- Shipbuilding
- Wind Energy



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The World's Greatest Organizations Trust ITI's Expertise with their Crane & Rigging Operations

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Past Presentations:

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- 9 Questions You Must Ask When Selecting a Crane and Rigging Training Provider
- Crane Accident Investigation
- Terex Presents: Ground Condition and Preparation for Mobile Cranes
- Rigger & Signal Person 1926.1400
- Ground Condition Surveys & Stabilization Techniques
- Winch, Drag or Roll?

Today's Presentation:

Ground Bearing Pressure: Practical Applications for Lifts of All Sizes

Coming up Next:

Load Distribution: Trolley Beams and 2-Crane Picks

MIKE PARNELL– ABOUT YOUR HOST

Mr. Parnell has a wealth of knowledge regarding cranes, rigging, and lifting activities throughout a variety of industries.

- 30+ years learning about wire rope, rigging, load handling, and lifting activities.
- Vice Chair of the ASME B30 Main Committee which sets the standards in the U.S. for cranes and rigging.
- Chair of the AMSE P30 Main Committee which sets the standards for lift planning.

ASME standards are also adopted by many countries around the world.

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JIM JATHO – ABOUT YOUR GUEST SPEAKER

Mr. Jatho is still a newcomer to the heavy lift industry with only three years experience, but in that time has achieved 100+ Critical Lifts planned and executed without incident:

- In environments including oil refineries, chemical plants, fertilizer plants, windfarms, and nuclear power plants
- Involving cranes as large as 750 tonnes in capacity, and currently developing preliminary plans for the new Liebherr 1000 tonne crane.
- All while developing his own tools and software to aid in the lift planning process

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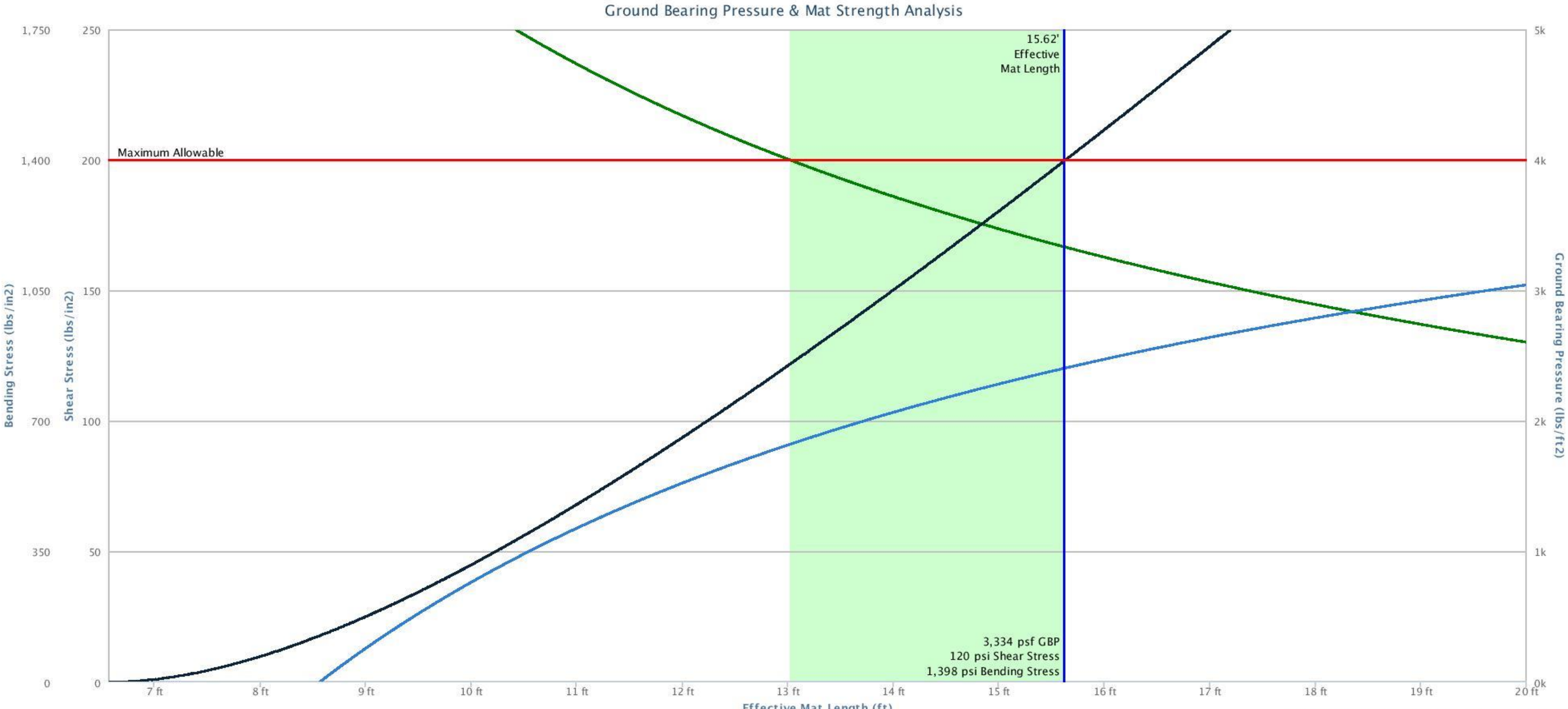
BUCKNER COMPANIES

STEEL / PRECAST / STACK ERECTION
HEAVYLIFT CRANES
INDUSTRIAL RIGGING
MISCELLANEOUS FABRICATION

Ground Bearing Pressure:
Practical Applications for Lifts of All Sizes



LiftingLogistics.com/result/10

Rankings

National Ranking
American Crane and Transport
#13-most cranes (Total Lift Capacity)
#7- largest crane
#8-largest crawler crane fleet

Engineering News Record
#9-Steel Erection

World Ranking
International Crane
#22- most cranes (Total Lift Capacity)

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HEAVYLIFT CRANES

Industrial Training
INTERNATIONAL
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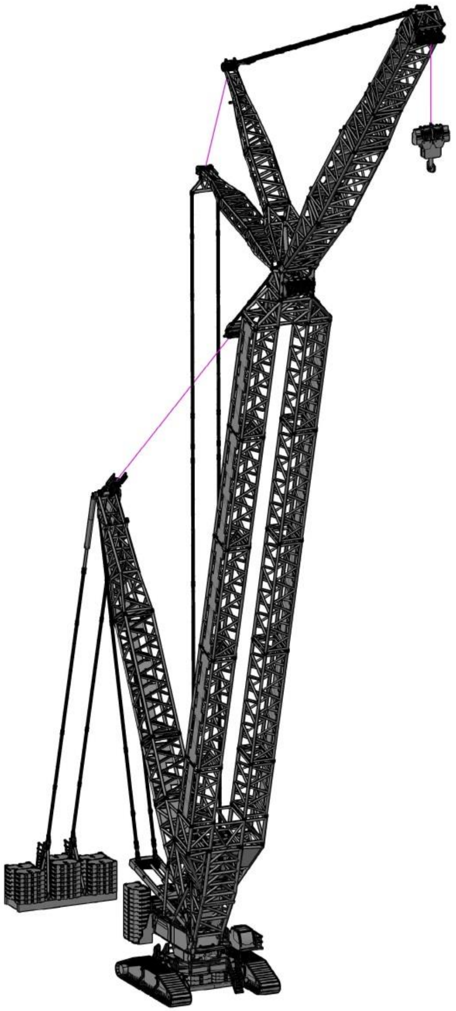
Our Fleet

CRAWLER CRANE FLEET

mulitple units

IHI CCH-700	72T
Terex HC-80	80T
Mantis Tele-Crawler 20010	100T
Liebherr Tele-Crawler LTR-1100	110T
Terex HC-110	110T
Kobelco CK-1600	160T
Manitowoc 777	200T
Manitowoc 888	230T
Manitowoc 999	275T
Liebherr LR-1350	385T
Liebherr LR-1400/1&2	440T**
Demag 2800-1/NT	660T**
Liebherr LR-1600/2	660T**
Liebherr LR-1750	825T**
Liebherr LR-11000	1100T**
Liebherr LR-11000/P1300	1433T**

**Significant capacity increase when utilizing heavy lift attachments



The Reason

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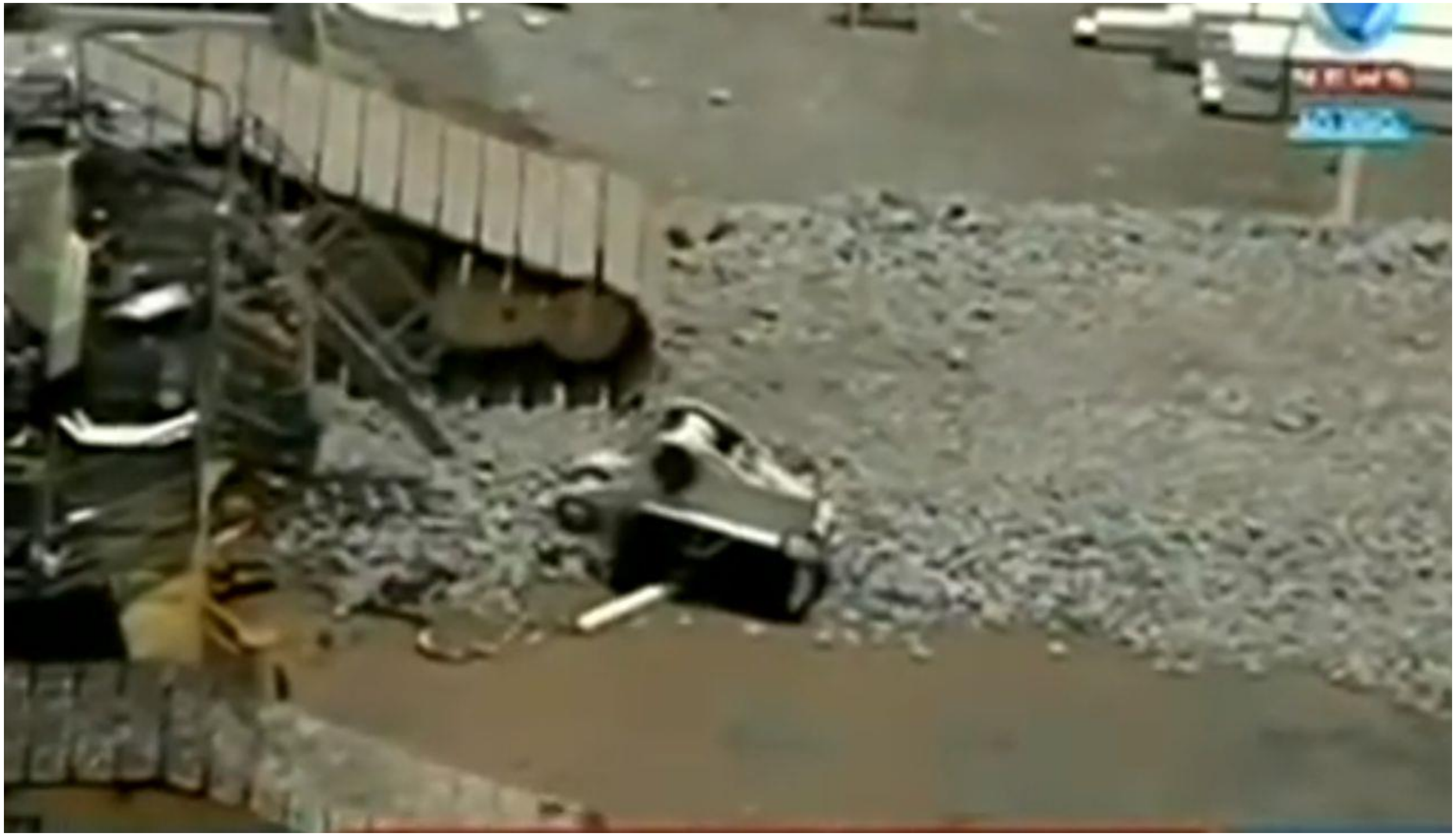
The Reason



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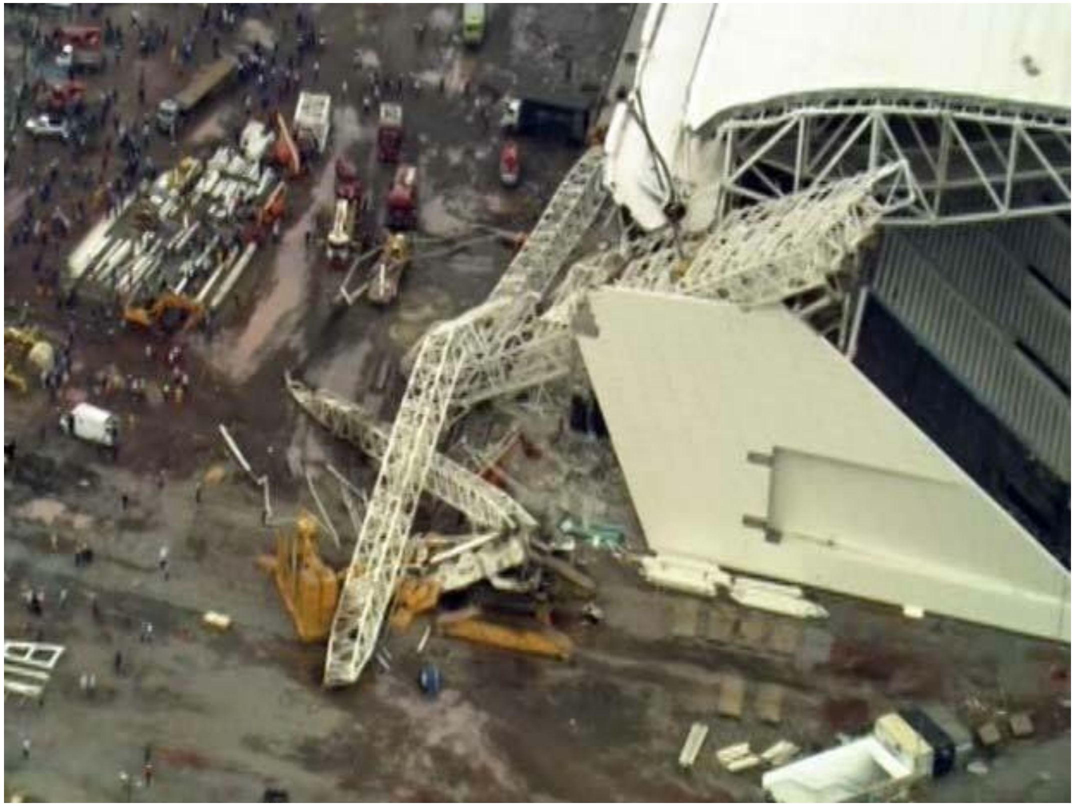

- LR 11350, 102m Main Boom, 42m Derrick with Ballast Tray

- 2,185 tonnes gross crane weight

- 39.02 tonnes / m² (7,993lbs/ft²) Beneath tracks

- "The LR11350 was only working at 82% of the Load Chart"

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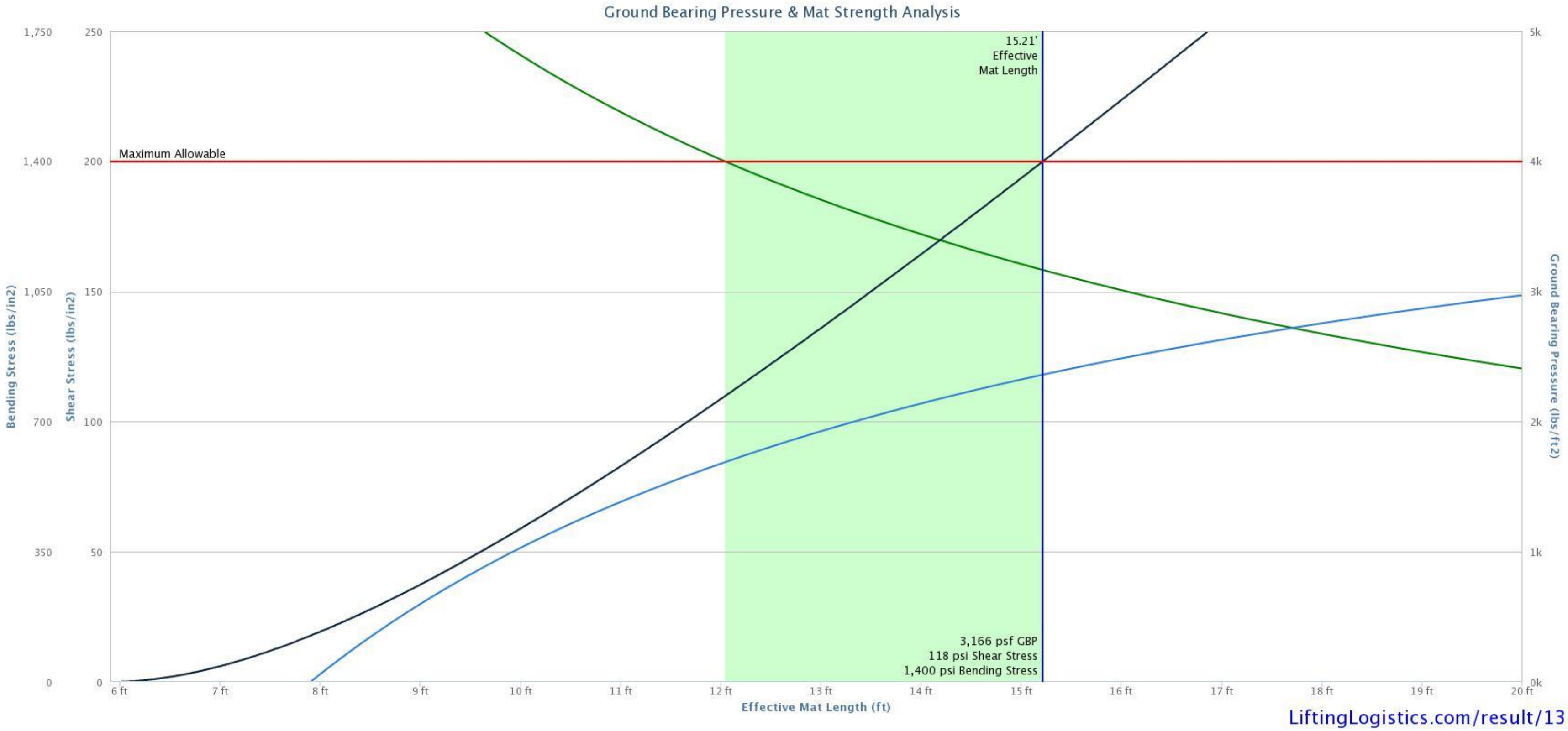

T_L	Track bearing length	37.00 ft		Soil Bearing Method			Mat Strength Method			Ground bearing pressure:
C	Bearing width of track	5.90 ft	P	Load applied to one mat	188,635 lbs	P	Crane load applied to one mat	188,635 lbs		79.16% of allowable capacity
T_{TL}	Track toe load	7,993 lbs/ft²	A_{reqd}	Required mat bearing area	48.16 ft²	L_c	Cantilevered length of mat	4.66 ft		Bending stress in mat:
T_{HL}	Track heel load	7,993 lbs/ft²	L_{reqd}	Required effective length	12.04 ft	q	GBP due to P	3,101 lbs/ft²		99.98% of allowable capacity
B	Mat width	4.0 ft	L_c	Cantilevered length of mat	3.07 ft	M	Bending moment in the mat	1,612,439 lb-in		Shear stress in mat:
W	Mat Length	20.0 ft	q	GBP due to P	3,917 lbs/ft²	f_b	Bending stress due to M	1400 lbs/in²		59.02% of allowable capacity
d	Mat thickness	12.0 in	M	Bending moment in the mat	885,909 lb-in	V	Shear in the mat	45,329 lbs		
W	Weight of mat	4,000 lbs	f_b	Bending stress due to M	769 lbs/in²	f_v	Shear stress due to V	118 lbs/in²		
q_a	Allowable GBP	4,000 lbs/ft²	V	Shear in the mat	32,430 lbs	q_t	actual GBP	3,166 lbs/ft²		
F_b	Allowable bending stress	1,400 lbs/in²	f_v	Shear stress due to V	84 lbs/in²					
F_v	Allowable shear stress	200 lbs/in²	q_t	Maximum GBP	4,000 lbs/ft²					
L_{eff}	Assumed effective length	15.21 ft								

Pressure Beneath Mats: 3,166 lbs/ft²

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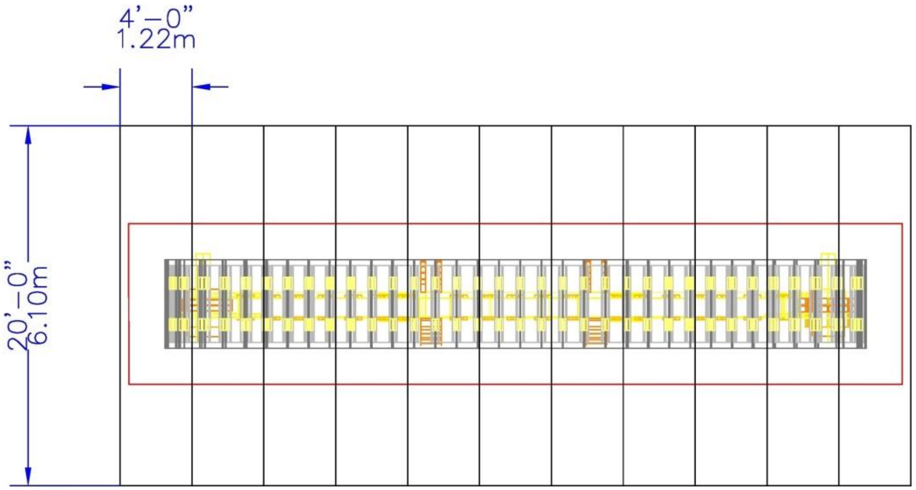
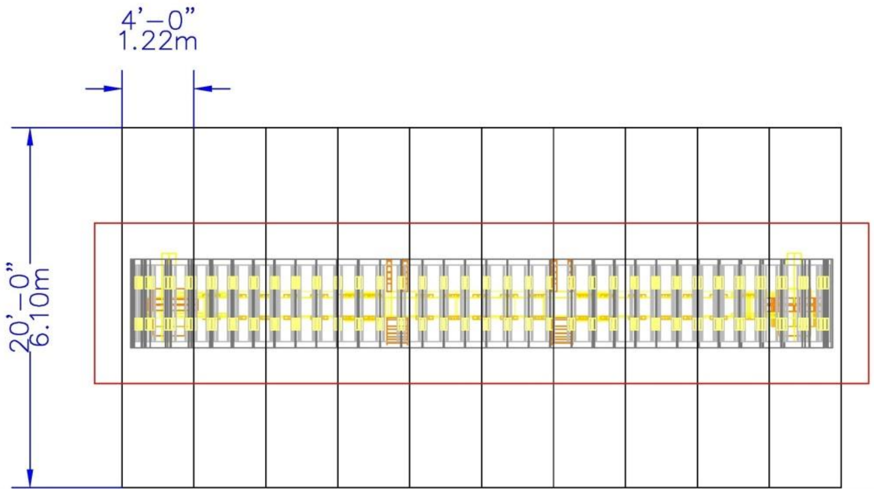
Where This Started





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The Source

- Mat Length Based on Soil Bearing Capacity
- Mat Length Based on Mat Strength

GTP EUROPE B.V.

Effective Bearing Length of Crane Mats

David Duerr, P.E.
2DM Associates, Inc., Consulting Engineers
Houston, Texas

INTRODUCTION

Crane mats are used to distribute the high concentrated loads from mobile cranes over a relatively large ground area so that the soil is loaded at tolerable bearing pressures. This has been common construction industry practice for many decades. Although crane mats are most commonly made of heavy timbers, fabricated steel mats are occasionally used under large cranes or when soil conditions are poor.

The analysis of a crane mat requires a determination of the length of the mat that actually bears on the soil and contributes to the support of the crane. At working loads, this is a relatively simple "beam on an elastic foundation" problem. However, such a solution may not produce a realistic result due to the nonlinearity of the soil as the ultimate bearing capacity is approached. Further, the elastic properties of the soil needed to perform such an analysis are not often available.

The purpose of this paper is to develop a practical means of calculating the effective bearing length of a crane mat that is based on readily available values and that produces an acceptably safe and reliable result.

CURRENT PRACTICE

Engineers in construction presently use a number of different approaches to design crane mats. The two most common of these methods are described here.

Mat Length Based on Soil Bearing Capacity

This crane mat design method is the most straightforward. Once the load from the crane has been calculated, whether an outrigger load or a crawler track pressure, the required crane mat area is calculated by dividing the crane load plus the weight of the mat by the allowable ground bearing pressure. Divide this area by the width of the mat and we have the required effective bearing length. This mat length is then used to calculate bending and shear stresses in the mat, based on the assumption of a uniform pressure equal to the crane load divided by the bearing area acting upward on the bottom of the mat. If the actual stresses are equal to or less than the allowable stresses, the mat is acceptable. This method can be written in equation form as follows. The basic arrangement is illustrated in Fig. 1. Note that Eqs. 7 and 8 are written for the design of timber crane mats. The term d in Eq. 7 and the coefficient 1.5 in Eq. 8 are not used for the design of steel mats.

$$A_{reqd} = \frac{P+W}{q_a} \quad (1)$$

$$L_{reqd} = \frac{A_{reqd}}{B} \quad (2)$$

$$L_c = \frac{L_{reqd} - C}{2} \quad (3)$$

$$q = \frac{P}{L_{reqd} B} \quad (4)$$

$$M = \frac{(qB) L_c^2}{2} \quad (5)$$

$$f_b = \frac{M}{Bd^2/6} \le F_b \quad (6)$$

$$V = (qB)(L_c - d) \quad (7)$$

$$f_v = \frac{1.5V}{Bd} \le F_v \quad (8)$$

where:

P = crane load applied to one mat;
W = self-weight of the mat;

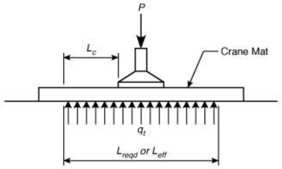


Fig. 1. Simple Crane Mat Arrangement

Mat Length Based on Soil Bearing Capacity

$$A_{reqd} = \frac{P + W}{q_a} \quad (1)$$

$$L_{reqd} = \frac{A_{reqd}}{B} \quad (2)$$

$$L_c = \frac{L_{reqd} - C}{2} \quad (3)$$

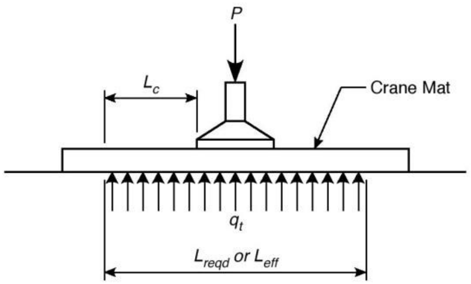
$$q = \frac{P}{L_{reqd} B} \quad (4)$$

$$M = \frac{(qB) L_c^2}{2} \quad (5)$$

$$f_b = \frac{M}{Bd^2/6} \leq F_b \quad (6)$$

$$V = (qB)(L_c - d) \quad (7)$$

$$f_v = \frac{1.5V}{Bd} \leq F_v \quad (8)$$



P = crane load applied to one mat;
W = self-weight of the mat;
q_a = allowable ground bearing pressure;
A_{reqd} = required mat bearing area;
B = mat width;
L_{reqd} = required effective bearing length of the mat;
C = bearing width of the track or outrigger pad;
L_c = cantilevered length of the mat;
q = ground bearing pressure due to P;
M = bending moment in the mat;
d = mat depth (or thickness);
f_b = bending stress due to M;
F_b = allowable bending stress;
V = shear in the mat;
f_v = shear stress due to V; and,
F_v = allowable shear stress.

Mat Length Based on Mat Strength

$$L_c = \frac{L_{eff} - C}{2} \quad (9)$$

$$q = \frac{P}{L_{eff} B} \quad (10)$$

$$M = \frac{(qB) L_c^2}{2} \quad (11)$$

$$f_b = \frac{M}{Bd^2/6} = F_b \quad (12)$$

$$V = (qB)(L_c - d) \quad (13)$$

$$f_v = \frac{1.5V}{Bd} = F_v \quad (14)$$

$$q_t = \frac{P + W}{L_{eff} B} \leq q_a \quad (15)$$

P = crane load applied to one mat;
W = self-weight of the mat;
q_a = allowable ground bearing pressure;
A_{reqd} = required mat bearing area;
B = mat width;
L_{reqd} = required effective bearing length of the mat;
C = bearing width of the track or outrigger pad;
L_c = cantilevered length of the mat;
q = ground bearing pressure due to P;
M = bending moment in the mat;
d = mat depth (or thickness);
f_b = bending stress due to M;
F_b = allowable bending stress;
V = shear in the mat;
f_v = shear stress due to V; and,
F_v = allowable shear stress.
L_{eff} = effective mat bearing length;
q_t = actual ground bearing pressure; and,
all other terms are as previously defined.

Combining The Methods

T_L	Track bearing length	37.00	ft		Soil Bearing Method				Mat Strength Method			Ground bearing pressure:	
C	Bearing width of track	5.90	ft	P	Load applied to one mat	188,632	lbs	P	Crane load applied to one mat	188,632	lbs	79.15% of allowable capacity	
T_{TL}	Track toe load	7,993	lbs/ft²	A_{reqd}	Required mat bearing area	48.16	ft²	L_c	Cantilevered length of mat	4.66	ft	Bending stress in mat:	
T_{HL}	Track heel load	7,993	lbs/ft²	L_{reqd}	Required effective length	12.04	ft	q	GBP due to P	3,100	lbs/ft²	99.98% of allowable capacity	
B	Mat width	4.0	ft	L_c	Cantilevered length of mat	3.07	ft	M	Bending moment in the mat	1,612,411	lb-in	Shear stress in mat:	
W	Mat Length	20.0	ft	q	GBP due to P	3,917	lbs/ft²	f_b	Bending stress due to M	1400	lbs/in²	59.02% of allowable capacity	
d	Mat thickness	12.0	in	M	Bending moment in the mat	885,851	lb-in	V	Shear in the mat	45,329	lbs		
W	Weight of mat	4,000	lbs	f_b	Bending stress due to M	769	lbs/in²	f_v	Shear stress due to V	118	lbs/in²		
q_a	Allowable GBP	4,000	lbs/ft²	V	Shear in the mat	32,428	lbs	q_t	actual GBP	3,166	lbs/ft²		
F_b	Allowable bending stress	1,400	lbs/in²	f_v	Shear stress due to V	84	lbs/in²						
F_v	Allowable shear stress	200	lbs/in²	q_t	Maximum GBP	4,000	lbs/ft²		Pressure Beneath Mats:			3,166	lbs/ft²
L_{eff}	Assumed effective length	15.21	ft										

Applications of Crane Mats

- Outrigger pads under outriggers
- Hardwood mats under outriggers
- Hardwood mats under crawler tracks

Outrigger Pads

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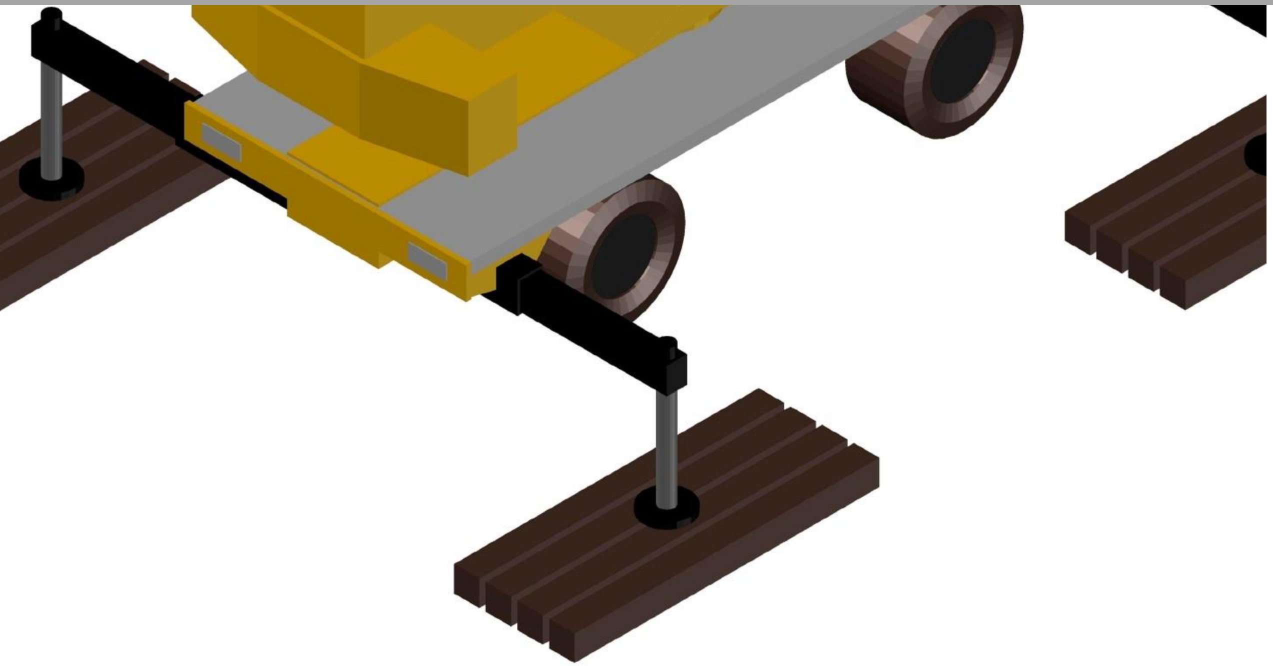
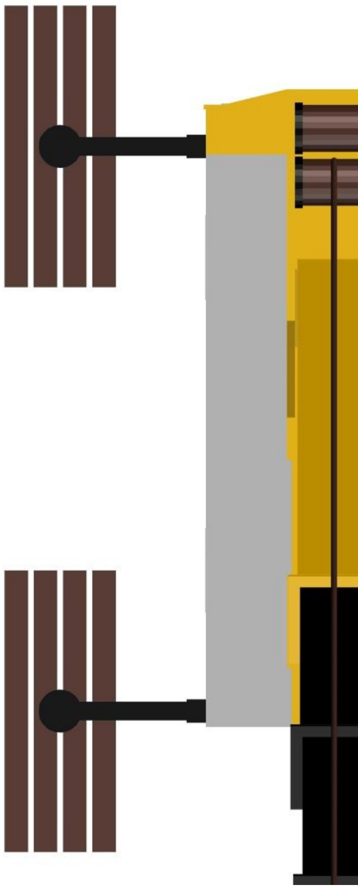
Outrigger Pad Data

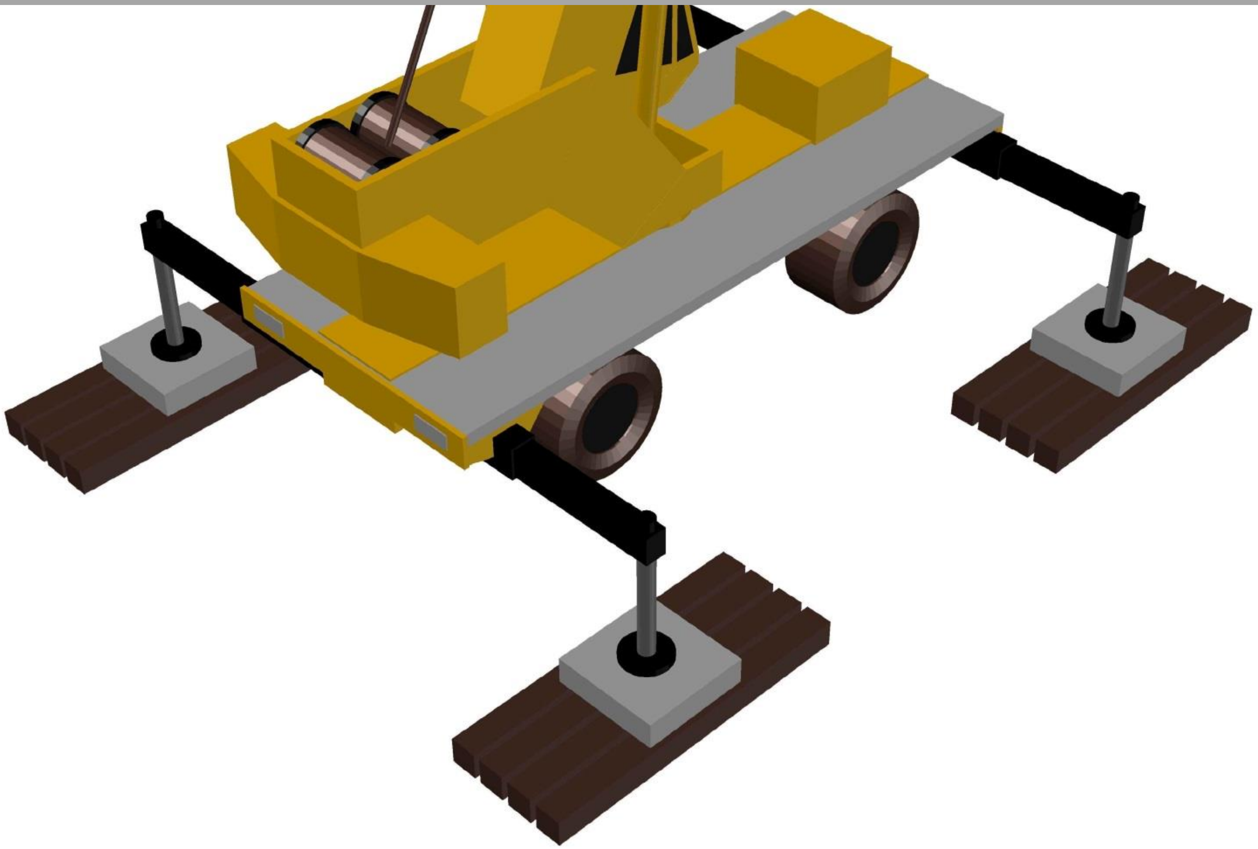
LOAD CAPACITY OF UHMW PADS (pounds)		WIDTH	LENGTH	THICKNESS	LBS	IN²	FT²
VERTICAL	45 ANGLE						
55,000	30,000	18″	18″	1″	11	324	2.25
60,000	35,000	22″	24″	1″	19	528	3.66
60,000	35,000	24″	24″	1″	20	576	4
62,000	40,000	24″	24″	2″	38	576	4
81,000	41,000	30″	30″	1″	31	900	6.25
85,000	43,000	30″	30″	2″	62	900	6.25
93,000	43,000	36″	36″	1″	45	1296	9
98,000	45,000	36″	36″	2″	90	1296	9
140,000	55,000	48″	48″	2″	160	2034	14.125

Outriggers on Crane Mats

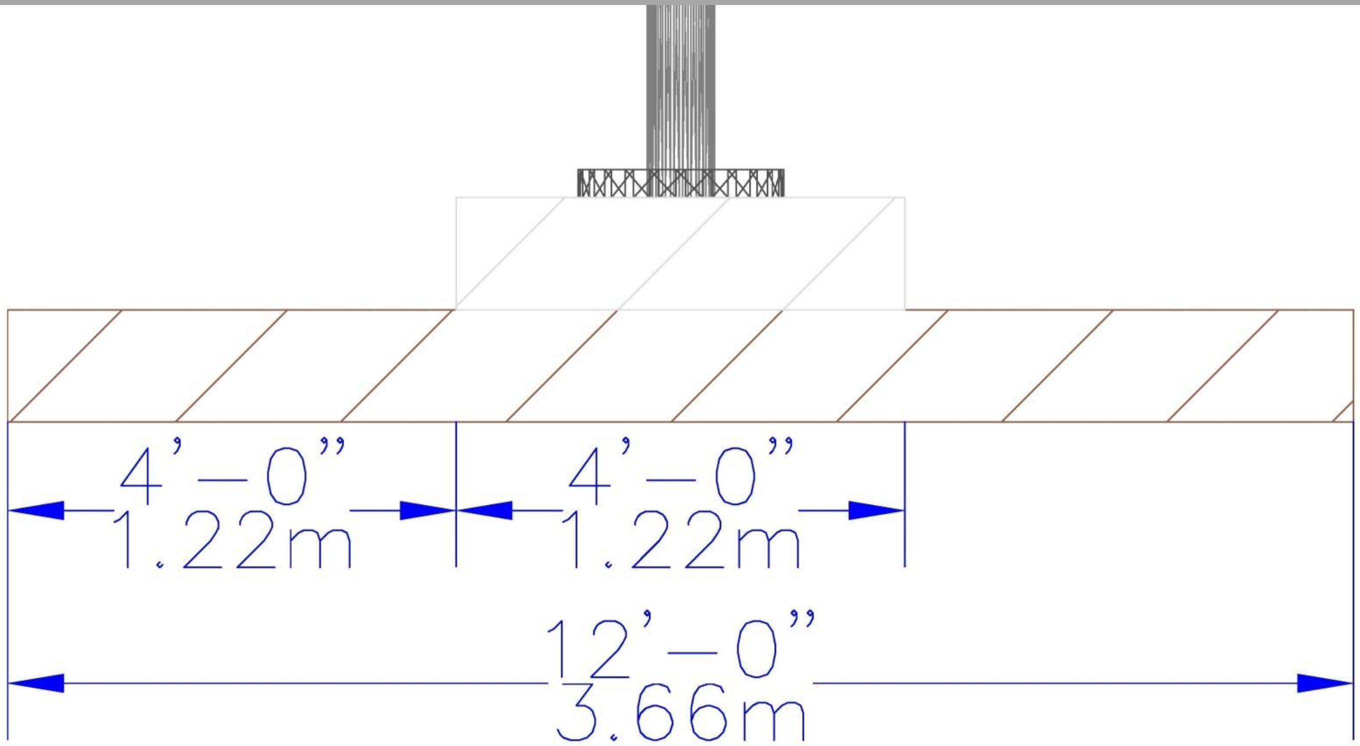




Transition Mats



Transition Mats



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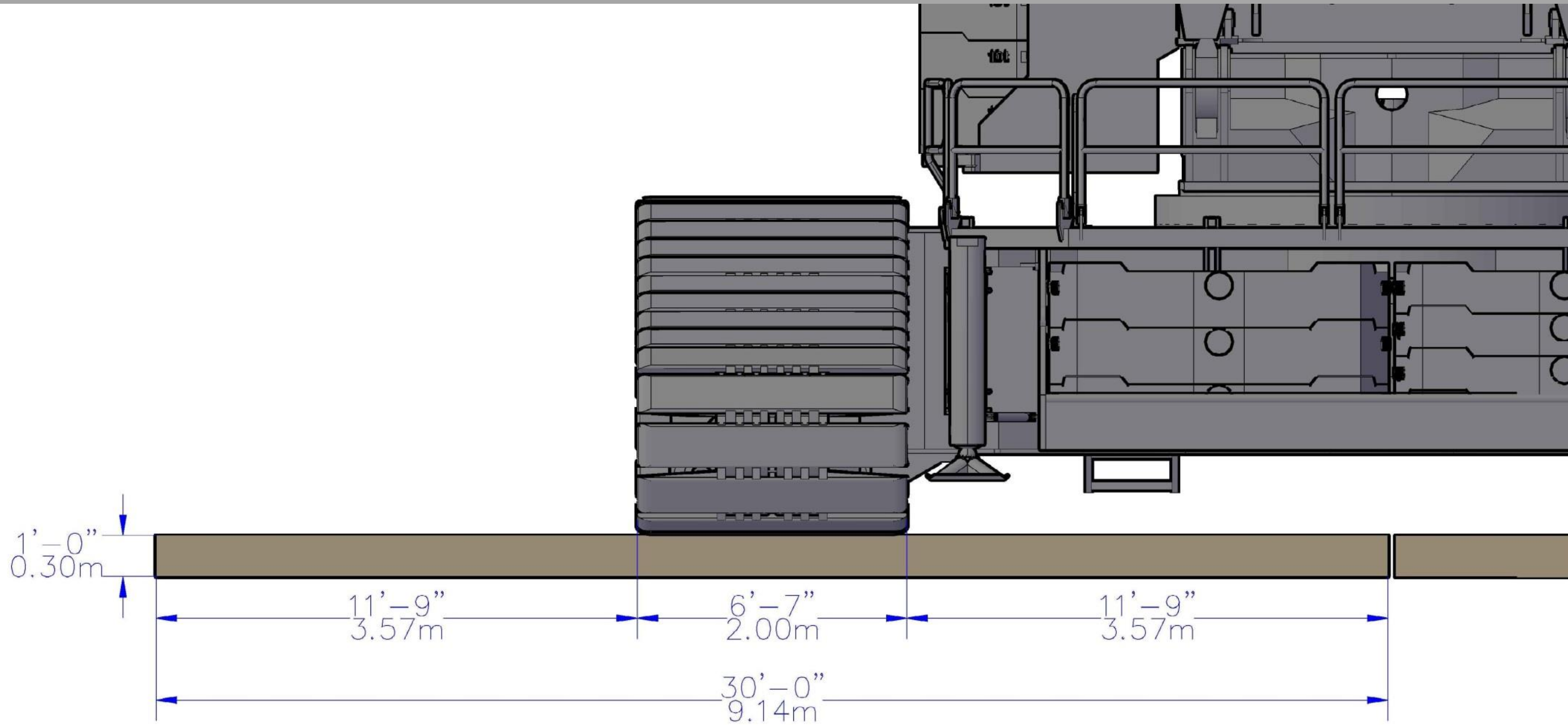
Crawlers on Mats



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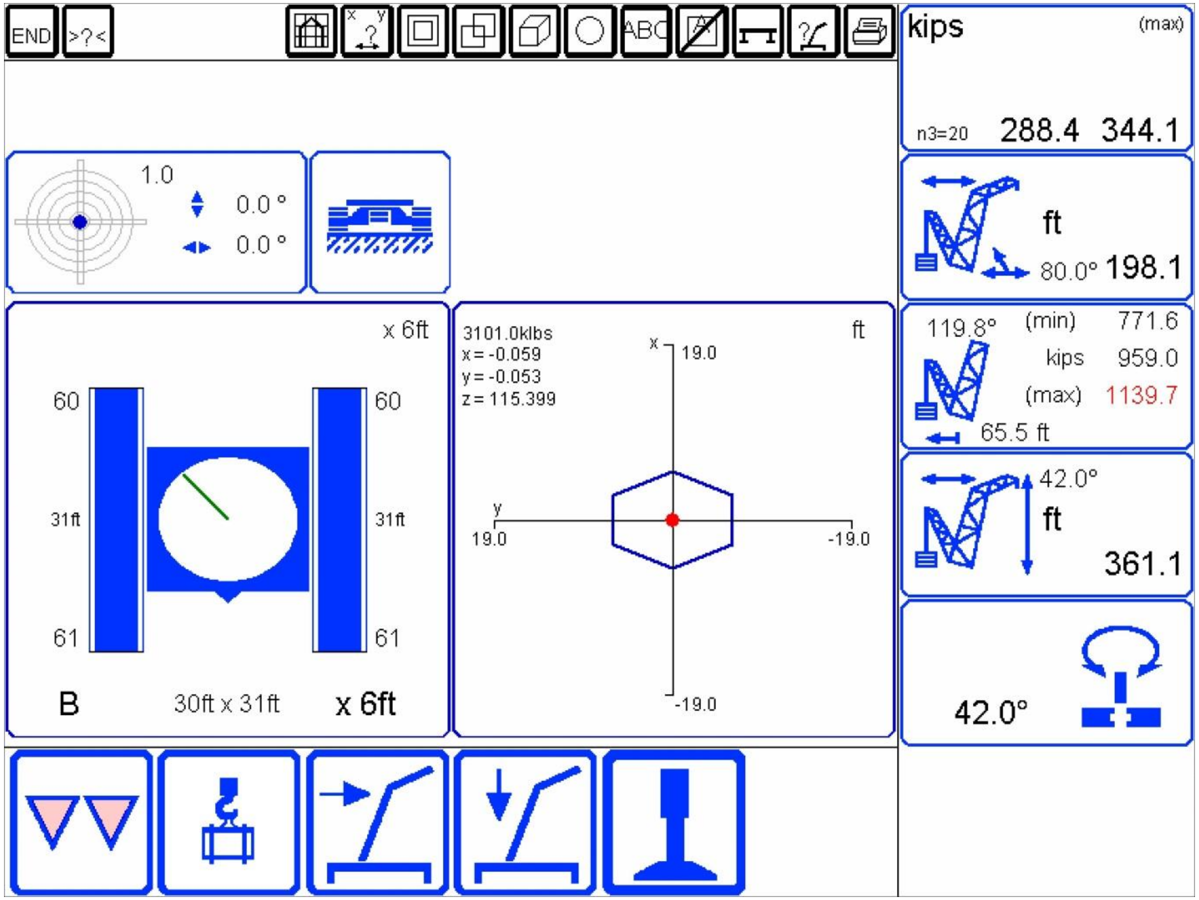
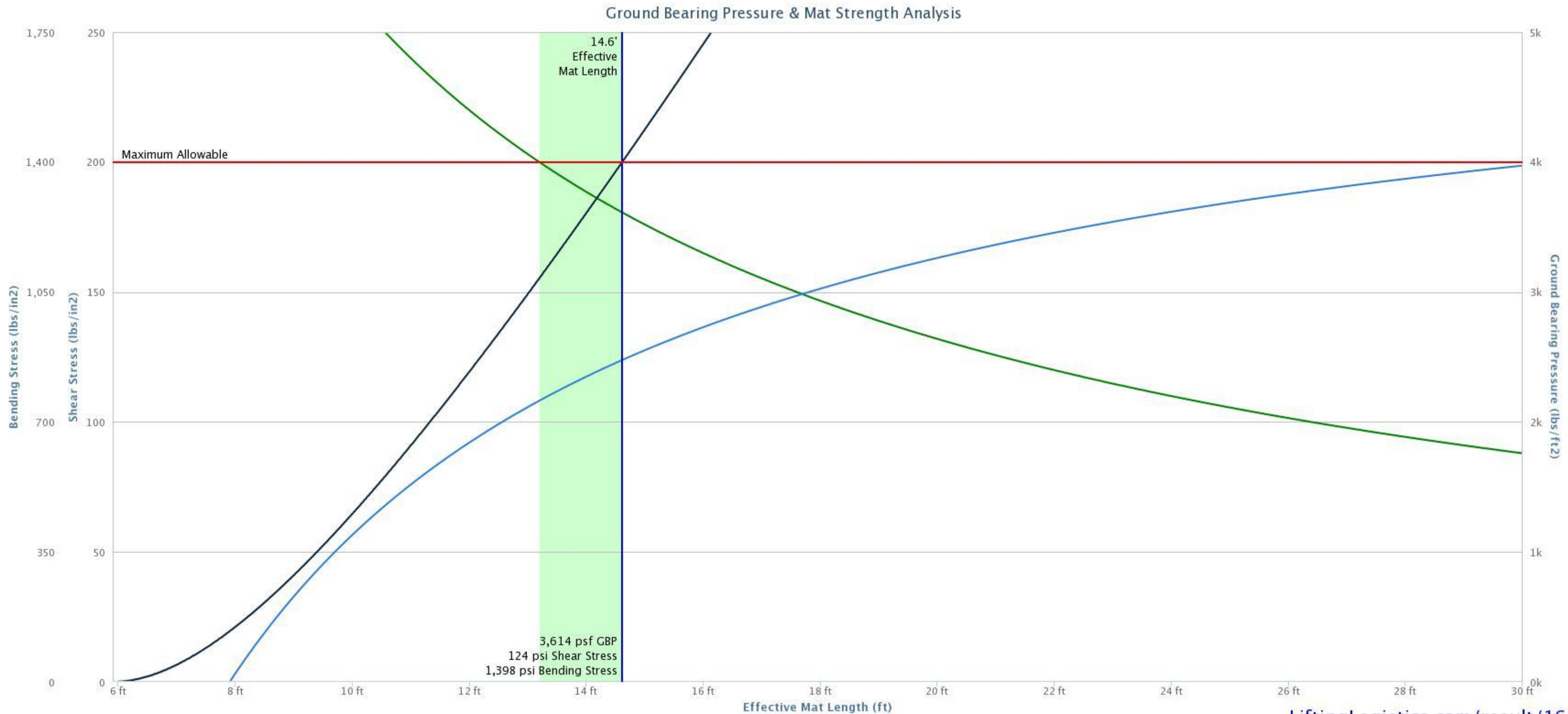
Crawler Example





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T_L	Track bearing length	31.49	ft
C	Bearing width of track	5.90	ft
T_{TL}	Track toe load	8,784	lbs/ft^2
T_{HL}	Track heel load	8,640	lbs/ft^2
B	Mat width	4.0	ft
W	Mat Length	30.0	ft
d	Mat thickness	12.0	in
W	Weight of mat	4,000	lbs
q_a	Allowable GBP	4,000	lbs/ft^2
F_b	Allowable bending stress	1,400	lbs/in^2
F_v	Allowable shear stress	200	lbs/in^2
L_{eff}	Assumed effective length	13.20	ft

	Soil Bearing Method		
P	Load applied to one mat	207,087	lbs
A_{reqd}	Required mat bearing area	52.77	ft^2
L_{reqd}	Required effective length	13.19	ft
L_c	Cantilevered length of mat	3.65	ft
q	GBP due to P	3,924	lbs/ft^2
M	Bending moment in the mat	1,252,288	lb-in
f_b	Bending stress due to M	1,087	lbs/in^2
V	Shear in the mat	41,541	lbs
f_v	Shear stress due to V	108	lbs/in^2
q_t	Maximum GBP	4,000	lbs/ft^2

	Mat Strength Method			Ground bearing pressure:
P	Crane load applied to one mat	207,087	lbs	99.95% of allowable capacity
L_c	Cantilevered length of mat	3.65	ft	Bending stress in mat:
q	GBP due to P	3,922	lbs/ft^2	77.76% of allowable capacity
M	Bending moment in the mat	1,254,050	lb-in	Shear stress in mat:
f_b	Bending stress due to M	1089	lbs/in^2	54.13% of allowable capacity
V	Shear in the mat	41,574	lbs	
f_v	Shear stress due to V	108	lbs/in^2	
q_t	actual GBP	3,998	lbs/ft^2	

Pressure Beneath Mats: 3,998 lbs/ft^2

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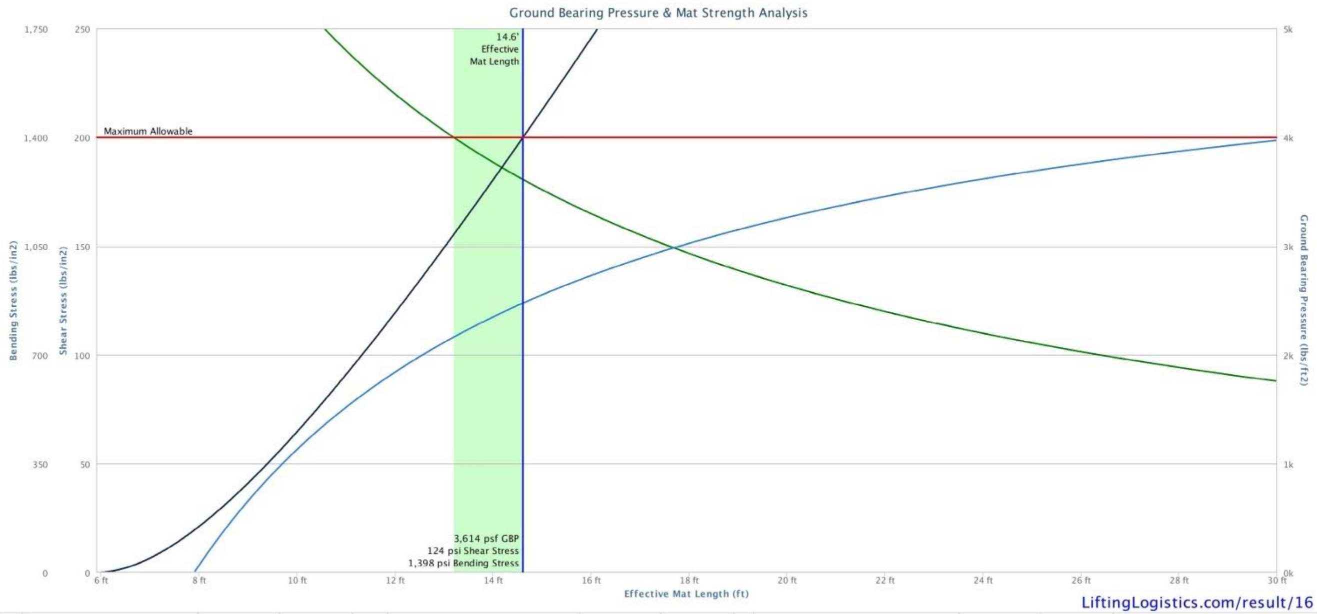
The Actual Report



LiftingLogistics.com/result/16

T_L	Track bearing length	31.49	ft		Soil Bearing Method				Mat Strength Method			Ground bearing pressure:
C	Bearing width of track	5.90	ft	P	Load applied to one mat	207,087	lbs	P	Crane load applied to one mat	207,087	lbs	99.95% of allowable capacity
T_{TL}	Track toe load	8,784	lbs/ft^2	A_{reqd}	Required mat bearing area	52.77	ft^2	L_c	Cantilevered length of mat	3.65	ft	Bending stress in mat:
T_{HL}	Track heel load	8,640	lbs/ft^2	L_{reqd}	Required effective length	13.19	ft	q	GBP due to P	3,922	lbs/ft^2	77.76% of allowable capacity
B	Mat width	4.0	ft	L_c	Cantilevered length of mat	3.65	ft	M	Bending moment in the mat	1,254,050	lb-in	Shear stress in mat:
W	Mat Length	30.0	ft	q	GBP due to P	3,924	lbs/ft^2	f_b	Bending stress due to M	1089	lbs/in^2	54.13% of allowable capacity
d	Mat thickness	12.0	in	M	Bending moment in the mat	1,252,288	lb-in	V	Shear in the mat	41,574	lbs	
W	Weight of mat	4,000	lbs	f_b	Bending stress due to M	1,087	lbs/in^2	f_v	Shear stress due to V	108	lbs/in^2	
q_a	Allowable GBP	4,000	lbs/ft^2	V	Shear in the mat	41,541	lbs	q_t	actual GBP	3,998	lbs/ft^2	
F_b	Allowable bending stress	1,400	lbs/in^2	f_v	Shear stress due to V	108	lbs/in^2					
F_v	Allowable shear stress	200	lbs/in^2	q_t	Maximum GBP	4,000	lbs/ft^2		Pressure Beneath Mats:	3,998	lbs/ft^2	
L_{eff}	Assumed effective length	13.20	ft									

PROJECT:
Example Project

LOCATION: Graham, North Carolina
BUCKNER CONTACT: Keith Rind, KeithR@Bucknercompanies.com
LIFT PLAN BY: Jim Jatho, JJatho@Bucknercompanies.com

DRAWING NOTES:
Content

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Revisions

All Sheets Same Revision Level

Rev.	Date	Description
000	02.20.2013	Preliminary Planning & Initial Layout
001	----	----
002	----	----
003	----	----
004	----	----
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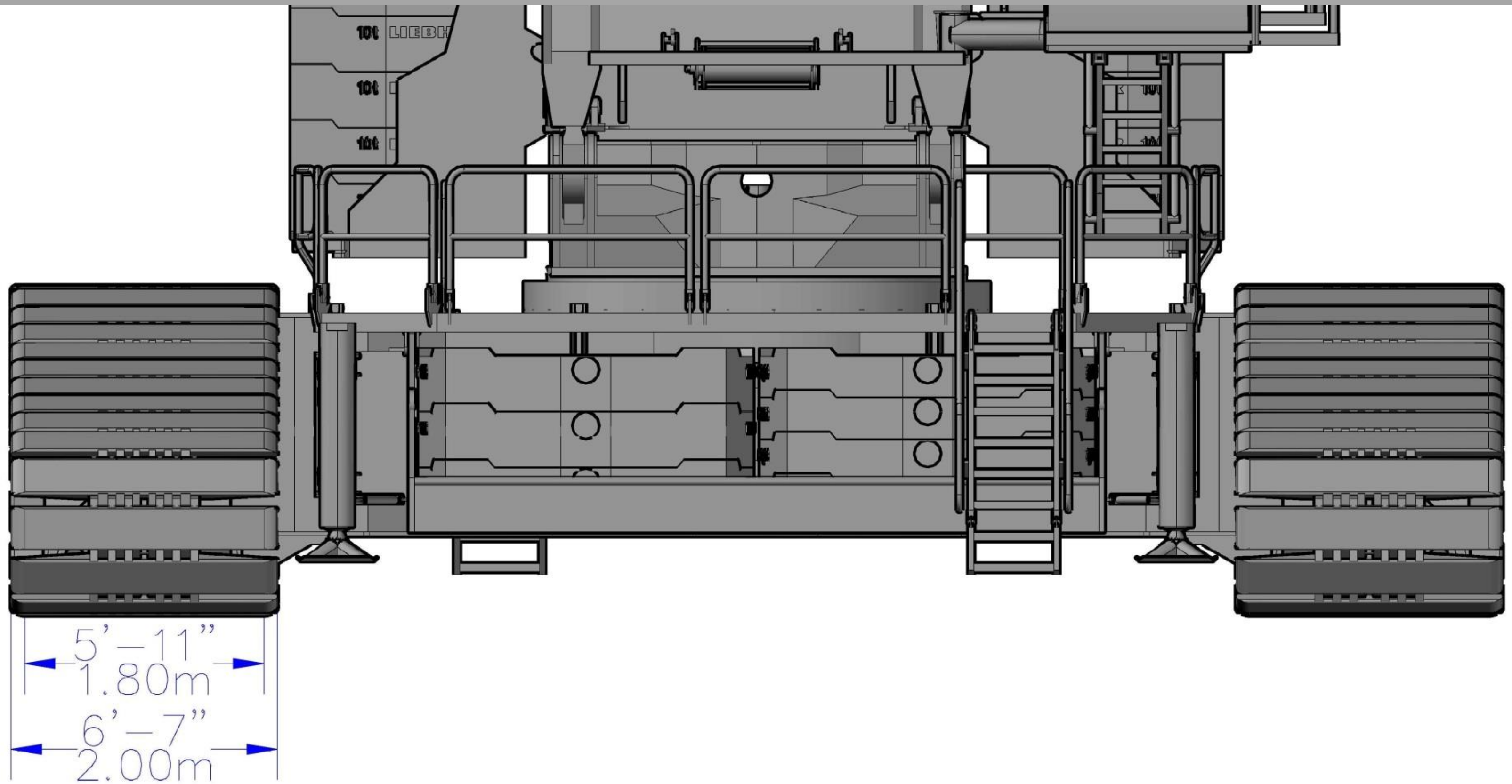
008	----	----
009	----	----
010	----	----

SHEET: 001 OF 001

BUCKNER HEAVYLIFT CRANES

Hard vs. Soft Ground



BUCKNER HEAVYLIFT CRANES

Industrial Training International
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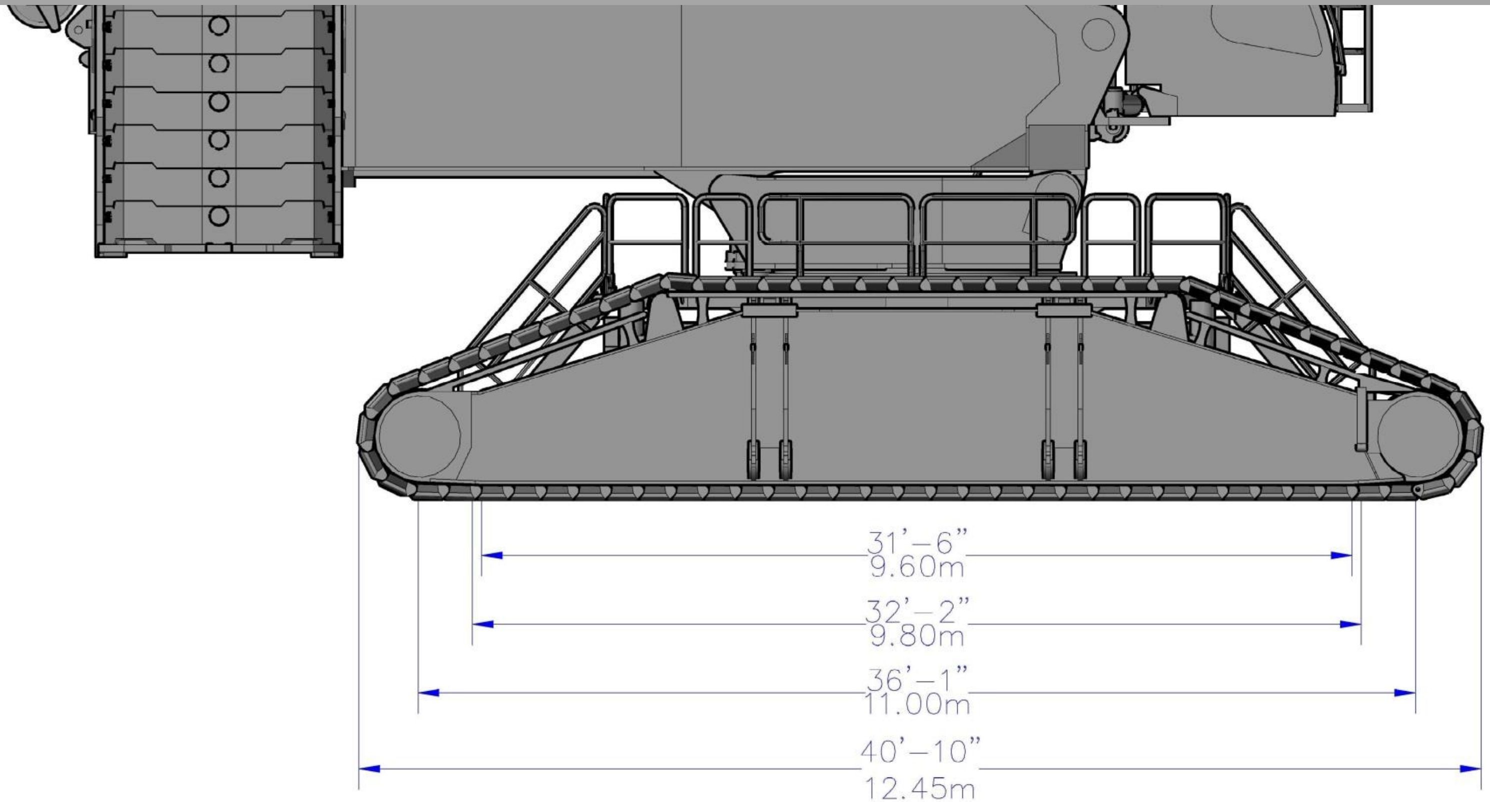
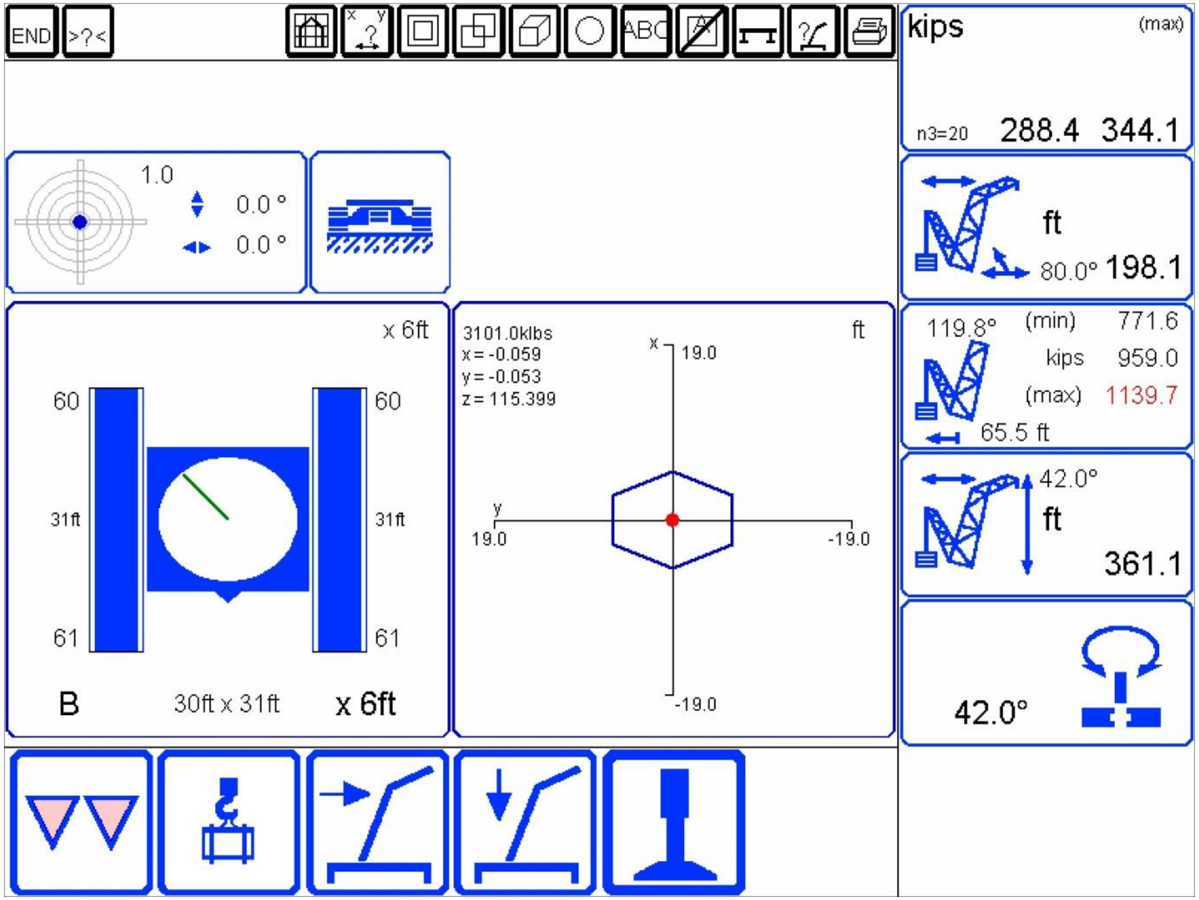
Hard vs. Soft Ground



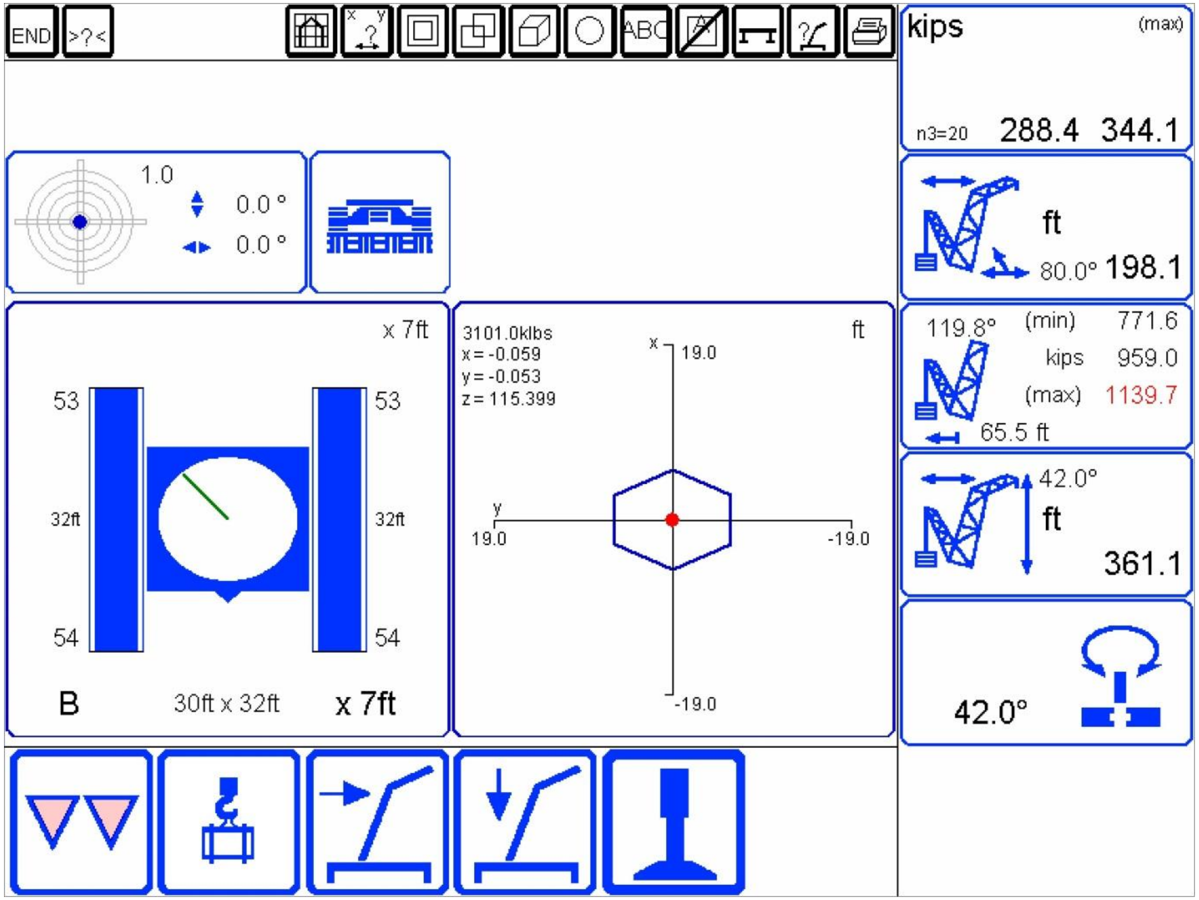
Hard vs. Soft Ground

	Soft Ground			Hard Ground			% Difference in bearing area
	Length (in)	Width (in)	Area (in²)	Length (in)	Width (in)	Area (in²)	
777	257.5	47.3	12179.75	209	20.3	4242.7	287%
888	296	47.3	14000.8	240	20.3	4872	287%
999	296	47.3	14000.8	240	20.3	4872	287%
16000	355	60	21300	296.5	50	14825	144%
18000	414.5	60	24870	348	50	17400	143%
LR 11000	385.82	78.74	30379.47	377.95	70.86	26781.54	113%

Hard Ground Numbers



Soft Ground Numbers



BUCKNER HEAVYLIFT CRANES

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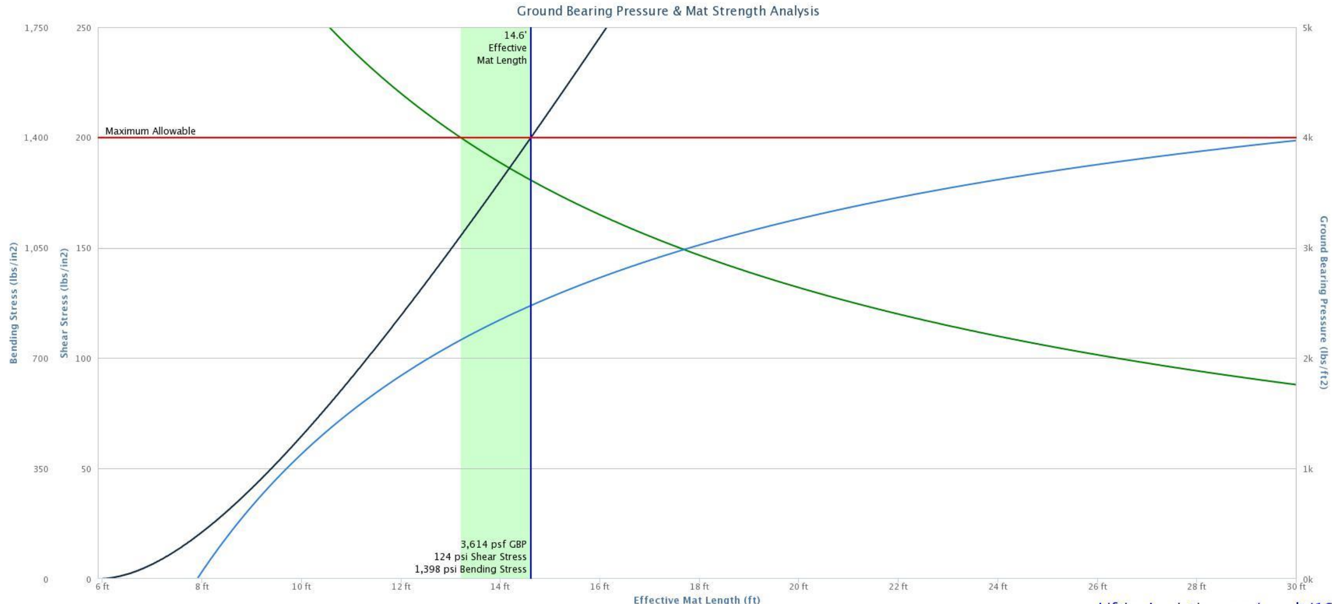

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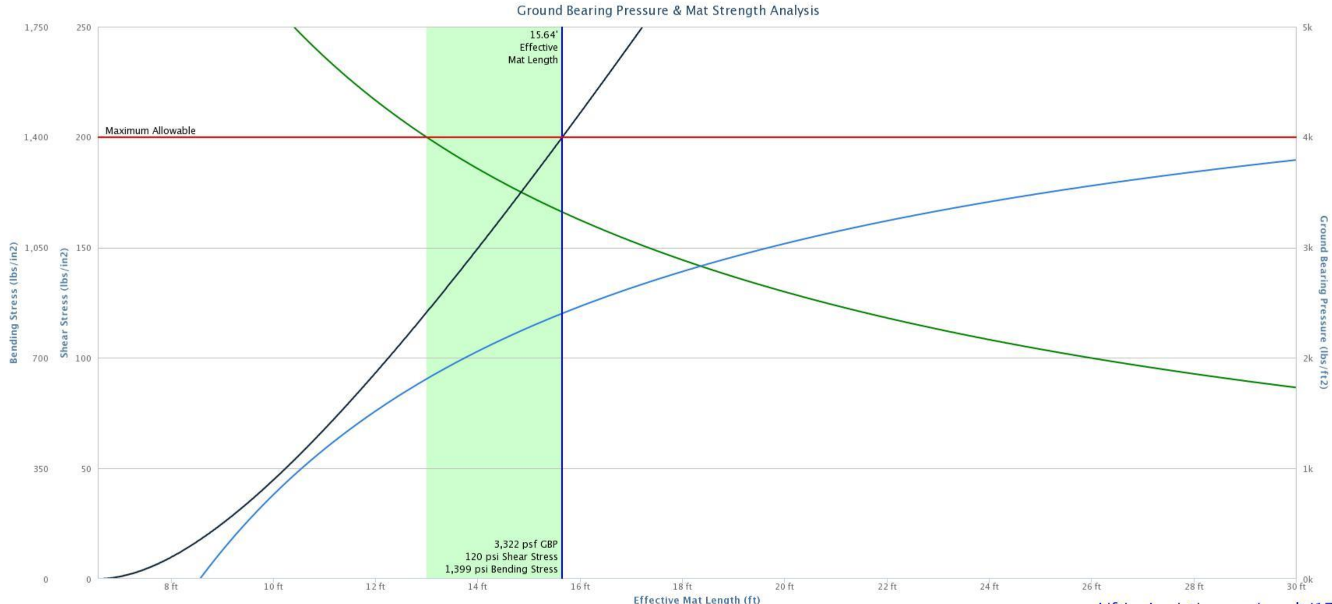


LiftingLogistics.com/result/17

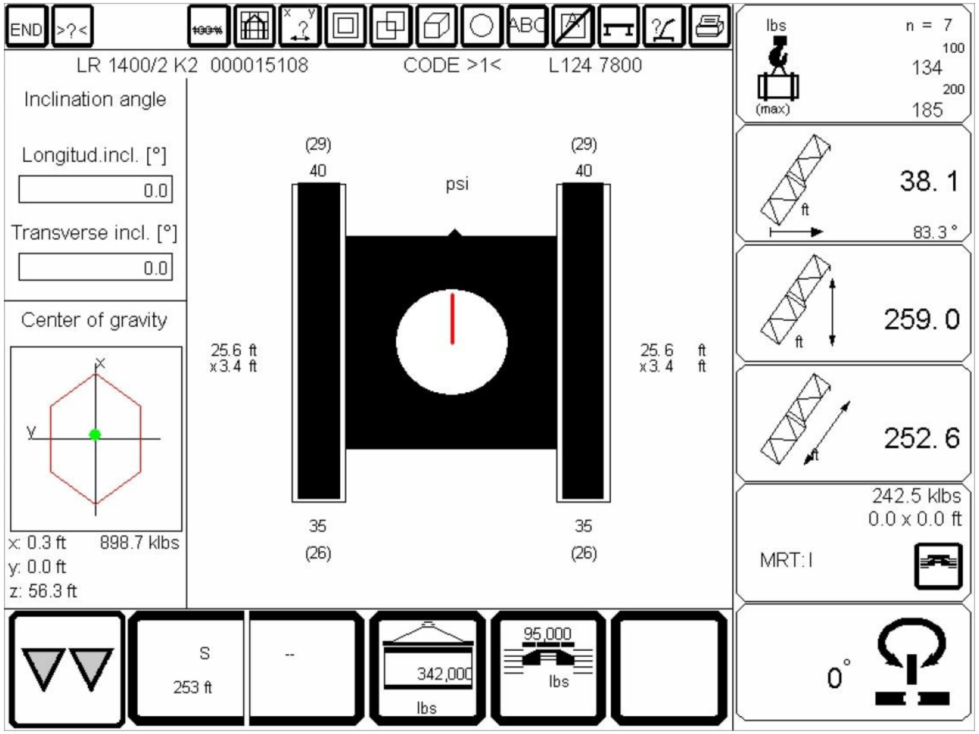
Hard vs. Soft Tables

T_L	Track bearing length	31.49	ft		Soil Bearing Method				Mat Strength Method			Ground bearing pressure:
C	Bearing width of track	5.90	ft	P	Load applied to one mat	207,087	lbs	P	Crane load applied to one mat	207,087	lbs	90.36% of allowable capacity
T_{TL}	Track toe load	8,784	lbs/ft^2	A_{reqd}	Required mat bearing area	52.77	ft^2	L_c	Cantilevered length of mat	4.35	ft	Bending stress in mat:
T_{HL}	Track heel load	8,640	lbs/ft^2	L_{reqd}	Required effective length	13.19	ft	q	GBP due to P	3,546	lbs/ft^2	99.85% of allowable capacity
B	Mat width	4.0	ft	L_c	Cantilevered length of mat	3.65	ft	M	Bending moment in the mat	1,610,382	lb-in	Shear stress in mat:
W	Mat Length	30.0	ft	q	GBP due to P	3,924	lbs/ft^2	f_b	Bending stress due to M	1398	lbs/in^2	61.87% of allowable capacity
d	Mat thickness	12.0	in	M	Bending moment in the mat	1,252,288	lb-in	V	Shear in the mat	47,516	lbs	
W	Weight of mat	4,000	lbs	f_b	Bending stress due to M	1,087	lbs/in^2	f_v	Shear stress due to V	124	lbs/in^2	
q_a	Allowable GBP	4,000	lbs/ft^2	V	Shear in the mat	41,541	lbs	q_t	actual GBP	3,614	lbs/ft^2	
F_b	Allowable bending stress	1,400	lbs/in^2	f_v	Shear stress due to V	108	lbs/in^2					
F_v	Allowable shear stress	200	lbs/in^2	q_t	Maximum GBP	4,000	lbs/ft^2		Pressure Beneath Mats:			3,614 lbs/ft^2
L_{eff}	Assumed effective length	14.60	ft									

T_L	Track bearing length	32.15	ft		Soil Bearing Method				Mat Strength Method			Ground bearing pressure:
C	Bearing width of track	6.56	ft	P	Load applied to one mat	203,807	lbs	P	Crane load applied to one mat	203,807	lbs	83.04% of allowable capacity
T_{TL}	Track toe load	7,776	lbs/ft^2	A_{reqd}	Required mat bearing area	51.95	ft^2	L_c	Cantilevered length of mat	4.54	ft	Bending stress in mat:
T_{HL}	Track heel load	7,632	lbs/ft^2	L_{reqd}	Required effective length	12.99	ft	q	GBP due to P	3,258	lbs/ft^2	99.92% of allowable capacity
B	Mat width	4.0	ft	L_c	Cantilevered length of mat	3.21	ft	M	Bending moment in the mat	1,611,557	lb-in	Shear stress in mat:
W	Mat Length	30.0	ft	q	GBP due to P	3,923	lbs/ft^2	f_b	Bending stress due to M	1399	lbs/in^2	60.07% of allowable capacity
d	Mat thickness	12.0	in	M	Bending moment in the mat	972,557	lb-in	V	Shear in the mat	46,130	lbs	
W	Weight of mat	4,000	lbs	f_b	Bending stress due to M	844	lbs/in^2	f_v	Shear stress due to V	120	lbs/in^2	
q_a	Allowable GBP	4,000	lbs/ft^2	V	Shear in the mat	34,742	lbs	q_t	actual GBP	3,322	lbs/ft^2	
F_b	Allowable bending stress	1,400	lbs/in^2	f_v	Shear stress due to V	90	lbs/in^2					
F_v	Allowable shear stress	200	lbs/in^2	q_t	Maximum GBP	4,000	lbs/ft^2		Pressure Beneath Mats:			3,322 lbs/ft^2
L_{eff}	Assumed effective length	15.64	ft									

Liebherr – Hard vs. Soft?

LR 1400, LR 1600, and LR 1750 have no additional allowance for bearing area in Liccon

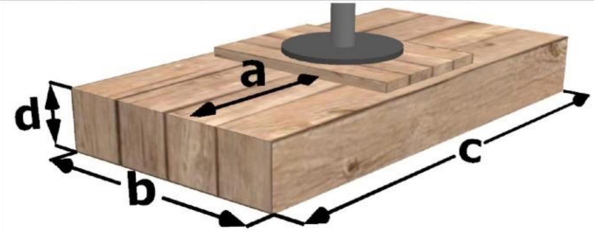


Load Case Scenarios

Ground Bearing Pressure – Grove GMK 7550, Maximum Radius, Fully Loaded.

Scenario	Front Left:	Front Right:	Aft Left:	Aft Right:
Directly Over Rear of Crane	95,591lbs	95,591lbs	259,409lbs	259,409lbs
Over Aft Left Outrigger	165,143lbs	71,204lbs	297,348lbs	176,291lbs
Directly Over Left Side	239,217lbs	106,339lbs	267,735lbs	96,609lbs
Over Front Left Outrigger	274,439lbs	180,413lbs	188,052lbs	67,096lbs
Directly Over Front of Crane	250,052lbs	250,052lbs	104,948lbs	104,948lbs
Over Front Right Outrigger	180,413lbs	274,439lbs	67,096lbs	188,052lbs
Directly Over Right Side	106,339lbs	239,217lbs	96,609lbs	267,735lbs
Over Aft Right Outrigger	71,204lbs	165,143lbs	176,291lbs	297,348lbs
Full 360 Degree Rotation	274,439lbs	274,439lbs	297,348lbs	297,348lbs

Mat Configuration: Three 4' x 12' by 1' mats side by side under a 10' x 8' x 11" steel transition mat per outrigger.



Crane Configuration:

Boom Length: 125.1' main boom, MegaWingLift

Counterweight: 352,700lbs

Support Base: 28'9" by 29'2"

Load Radius: Maximum of 60ft

Load Weight: 140,000lbs

Printed Large Dataset

BUCKNER
HEAVYLIFT CRANES

Contents

Sheet	Description	Sheet	Description	Sheet	Description
001	Title Page	031	253' S Boom 37737lbs Load Min Radius GBP	061	253' S Boom 128363lbs Load Max Radius GBP
002	Summary	032	253' S Boom 37737lbs Load Max Radius Liccon	062	253'+57' S2F2 0lbs Load Min Radius Liccon
003	253' S Boom Load Chart	033	253' S Boom 37737lbs Load Max Radius GBP	063	253'+57' S2F2 0lbs Load Min Radius GBP
004	253'-57' S2F2 Load Chart	034	253' S Boom 43670lbs Load Min Radius Liccon	064	253'+57' S2F2 0lbs Load Max Radius Liccon
005	Block Weight	035	253' S Boom 43670lbs Load Min Radius GBP	065	253'+57' S2F2 0lbs Load Max Radius GBP
006	253' S Boom 0lbs Load Min Radius Liccon	036	253' S Boom 43670lbs Load Max Radius Liccon	066	253'+57' S2F2 63641lbs Load Min Radius Liccon
007	253' S Boom 0lbs Load Min Radius GBP	037	253' S Boom 43670lbs Load Max Radius GBP	067	253'+57' S2F2 63641lbs Load Min Radius GBP
008	253' S Boom 0lbs Load Max Radius Liccon	038	253' S Boom 50791lbs Load Min Radius Liccon	068	253'+57' S2F2 63641lbs Load Max Radius Liccon
009	253' S Boom 0lbs Load Max Radius GBP	039	253' S Boom 50791lbs Load Min Radius GBP	069	253'+57' S2F2 63641lbs Load Max Radius GBP
010	253' S Boom 5601lbs Load Min Radius Liccon	040	253' S Boom 50791lbs Load Max Radius Liccon	070	253'+57' S2F2 78582lbs Load Min Radius Liccon
011	253' S Boom 5601lbs Load Min Radius GBP	041	253' S Boom 50791lbs Load Max Radius GBP	071	253'+57' S2F2 78582lbs Load Min Radius GBP
012	253' S Boom 5601lbs Load Max Radius Liccon	042	253' S Boom 52113lbs Load Min Radius Liccon	072	253'+57' S2F2 78582lbs Load Max Radius Liccon
013	253' S Boom 5601lbs Load Max Radius GBP	043	253' S Boom 52113lbs Load Min Radius GBP	073	253'+57' S2F2 78582lbs Load Max Radius GBP
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015	253' S Boom 8134lbs Load Min Radius GBP	045	253' S Boom 52113lbs Load Max Radius GBP	075	253'+57' S2F2 81719lbs Load Min Radius GBP
016	253' S Boom 8134lbs Load Max Radius Liccon	046	253' S Boom 59830lbs Load Min Radius Liccon	076	253'+57' S2F2 81719lbs Load Max Radius Liccon
017	253' S Boom 8134lbs Load Max Radius GBP	047	253' S Boom 59830lbs Load Min Radius GBP	077	253'+57' S2F2 81719lbs Load Max Radius GBP
018	253' S Boom 13664lbs Load Min Radius Liccon	048	253' S Boom 59830lbs Load Max Radius Liccon	078	253'+57' S2F2 112363lbs Load Min Radius Liccon
019	253' S Boom 13664lbs Load Min Radius GBP	049	253' S Boom 59830lbs Load Max Radius GBP	079	253'+57' S2F2 112363lbs Load Min Radius GBP
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021	253' S Boom 13664lbs Load Max Radius GBP	051	253' S Boom 81719lbs Load Min Radius GBP	081	253'+57' S2F2 112363lbs Load Max Radius GBP
022	253' S Boom 30541lbs Load Min Radius Liccon	052	253' S Boom 81719lbs Load Max Radius Liccon	082	253'+57' S2F2 128363lbs Load Min Radius Liccon
023	253' S Boom 30541lbs Load Min Radius GBP	053	253' S Boom 81719lbs Load Max Radius GBP	083	253'+57' S2F2 128363lbs Load Min Radius GBP
024	253' S Boom 30541lbs Load Max Radius Liccon	054	253' S Boom 112363lbs Load Min Radius Liccon	084	253'+57' S2F2 128363lbs Load Max Radius Liccon
025	253' S Boom 30541lbs Load Max Radius GBP	055	253' S Boom 112363lbs Load Min Radius GBP	085	253'+57' S2F2 128363lbs Load Max Radius GBP
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027	253' S Boom 32791lbs Load Min Radius GBP	057	253' S Boom 112363lbs Load Max Radius GBP		
028	253' S Boom 32791lbs Load Max Radius Liccon	058	253' S Boom 128363lbs Load Min Radius Liccon		
029	253' S Boom 32791lbs Load Max Radius GBP	059	253' S Boom 128363lbs Load Min Radius GBP		
030	253' S Boom 37737lbs Load Min Radius Liccon	060	253' S Boom 128363lbs Load Max Radius Liccon		

PROJECT:

LOCATION:

BUCKNER CONTACT: Kevin Long
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LIFT PLAN BY: Jim Jatho
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DRAWING NOTES:
Title Page

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Revisions

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Rev.	Date	Description
000	02.17.2014	Preliminary Planning & Initial Layout
001	----	----
002	----	----
003	----	----
004	----	----
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006	----	----
007	----	----
008	----	----
009	----	----
010	----	----

SHEET: 001 OF 085

BUCKNER
HEAVYLIFT CRANES

Printed Large Dataset

Ground Bearing Pressure Summary

Load Case	Minimum Radius	GBP At Minimum Radius	Maximum Radius	GBP At Maximum Radius
253' S 0lbs Load	38'-1"	2,729lbs/ft²	230'-0"	3,544lbs/ft²
253' S 5,601lbs Load	38'-1"	2,594lbs/ft²	213'-9"	3,982lbs/ft²
253' S 8,134lbs Load	38'-1"	2,548lbs/ft²	204'-8"	3,985lbs/ft²
253' S 13,664lbs Load	38'-1"	2,410lbs/ft²	187'-9"	3,992lbs/ft²
253' S 30,541lbs Load	38'-1"	2,142lbs/ft²	149'-8"	3,963lbs/ft²
253' S 32,791lbs Load	38'-1"	2,095lbs/ft²	145'-8"	3,967lbs/ft²
253' S 37,737lbs Load	38'-1"	2,005lbs/ft²	137'-10"	3,974lbs/ft²
253' S 43,670lbs Load	38'-1"	1,975lbs/ft²	129'-7"	3,984lbs/ft²
253' S 50,791lbs Load	38'-1"	1,835lbs/ft²	121'-0"	3,984lbs/ft²
253' S 52,113lbs Load	38'-1"	1,778lbs/ft²	119'-6"	3,987lbs/ft²
253' S 59,830lbs Load	38'-1"	1,705lbs/ft²	111'-6"	3,993lbs/ft²
253' S 81,719lbs Load	38'-1"	1,422lbs/ft²	93'-2"	3,911lbs/ft²
253' S 112,363lbs Load	38'-1"	1,048lbs/ft²	76'-6"	3,992lbs/ft²
253' S 128,363lbs Load	38'-1"	1,020lbs/ft²	69'-3"	3,902lbs/ft²
253'/57' S2F2 0lbs Load	45'-6"	2,556lbs/ft²	205'-4"	3,950lbs/ft²
253'/57' S2F2 69,361lbs Load	45'-6"	1,385lbs/ft²	103'-6"	3,967lbs/ft²
253'/57' S2F2 78,582lbs Load	45'-6"	1,156lbs/ft²	92'-7"	3,986lbs/ft²
253'/57' S2F2 81,179lbs Load	45'-6"	1,081lbs/ft²	90'-6"	3,931lbs/ft²
253'/57' S2F2 112,363lbs Load	45'-6"	1,201lbs/ft²	74'-9"	3,963lbs/ft²
253'/57' S2F2 128,363lbs Load	45'-6"	1,526lbs/ft²	68'-4"	3,918lbs/ft²

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LIFT PLAN BY: Jim Jatho
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009	----	----
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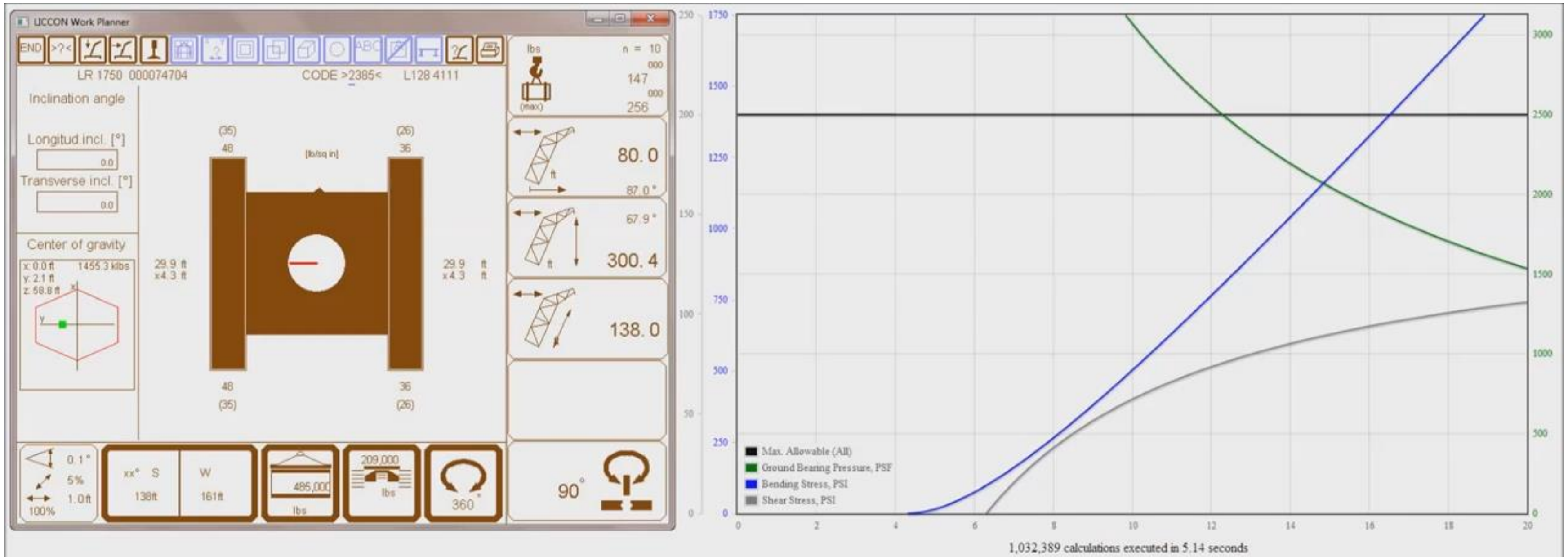
SHEET: 002 OF 085

BUCKNER HEAVYLIFT CRANES

GBP Analysis Animation



Frame	#000	Mat Width	4ft	Mat Weight	4,000lbs
Track Bearing Length	29.9ft	Mat Length	20ft	Radius	80ft
Track Bearing Width	4.3ft	Mat Thickness	12in	Chart Capacity	256,000lbs
Track Toe Load	6,912lbs/ft²				
Track Heel Load	6,912lbs/ft²	Load Weight		147,000lbs (57.42%)	

Bending Stress (1,400lbs/in² Max.)	1,399lbs/in² (99.93%)	Loading Condition (144,100lbs Max.)	118,886lbs (82.5%)
Shear Stress (200lbs/in² Max.)	95.8lbs/in² (47.9%)	Actual GBP (2,500lbs/ft² Max.)	1,860lbs/ft² (74.39%)

Summary

- Are all timbers of the mat being loaded when under an outrigger?
- Is the full length of the mat being considered as "effective"?
  - If so, what are the bearing and shear stresses in the mat?
  - If not, what effective length is bearing into the soil?
- Have all worst case scenarios been considered?
  - Empty hook conditions?
  - Worst case swing angles?
  - Crane erection?
- Are hard ground or soft ground numbers being used for crawler track pressures?
  - Does the effective bearing area of the tracks match the soft/hard ground condition?
  - If soft ground numbers are being used, what is the justification?

QUESTIONS?